PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P72844PC00	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/EP2005/011010	International filing date *(day/month/year)* 11.10.2005	Priority date *(day/month/year)* 28.10.2004

International Patent Classification (IPC) or national classification and IPC
INV. G06T7/00 G06T5/00

Applicant
FOTONATION VISION LIMITED et al.

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 11 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 7 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☒	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
25.05.2006	23.01.2007

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2005/011010

Box No. I Basis of the report

1. With regard to the **language**, this report is based on

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3(a) and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4(a))
   - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-30	as originally filed

Claims, Numbers

1-47	received on 25.05.2006 with letter of 25.05.2006

Drawings, Sheets

1-12	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☒ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☒ the claims, Nos. 48-52
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. IV Lack of unity of invention

1. ☐ In response to the invitation to restrict or pay additional fees, the applicant has, within the applicable time limit:

   ☐ restricted the claims.

   ☐ paid additional fees.

   ☐ paid additional fees under protest and, where applicable, the protest fee.

   ☐ paid additional fees under protest but the applicable protest fee was not paid.

   ☐ neither restricted the claims nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is:

   ☐ complied with.

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, this report has been established in respect of the following parts of the international application:

   ☒ all parts.

   ☐ the parts relating to claims Nos. .

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	5,29
	No:	Claims	1-4,6-28,30-47
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-47
Industrial applicability (IA)	Yes:	Claims	1-47
	No:	Claims	

2. Citations and explanations (Rule 70.7):

   see separate sheet

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2005/011010

1 Reference is made to

D1: US2003/0142285 A1
D2: US2003/0095197 A1
D3: US2003/0044070 A1

Re Item IV

2 The application lacks unity since the following two groups of claims fail to share corresponding special technical features defining a common inventive concept:

Group 1: Claims 1-24: (if clarified) relate to detecting red-eyes in an acquired image based on a first acquired image which has been previously corrected if analysis of said first image determined this to be beneficial.

Group 2: Claims 25-47: (if clarified) relate to analysing a first acquired image for adaptively modifying a filter chain to detect red eye defects in an acquired image

2.1 The subject matter of these two groups of claims fails to define a common inventive concept:

2.2 The common concept of both groups relates to using information extracted by image analysis from a first image to influence the overall process of red eye detection in an image: this is known from both D1 and D2, w.r.t. D1 cf. i.a. Fig. 2: ref. sign 62 receiving input from 40 and 58 and influencing 55, and w.r.t. D2 cf. i.a. Fig. 2: ref. signs 62,64 influencing the processing chain 70.

2.3 The remaining features and concepts are not common to both sets of claims, in particular there is no mention of a filter chain in group 1, nor is there any mentioning of testing whether correcting the first image would be beneficial in group 2. Moreover, while in group 1 the characteristics are used to correct first image data which is then used to influence the processing of an image, in group 2 the characteristics are rather used to modify a filter chain - see i.a. also pg. 14 line 3 (Fig. 2c) "..*instead of* corrective image processing...the analyser .. adapts the red eye filter chain.." and lines 18-20 "..to modify the filter chain ... *as opposed to* modification of the image pixels". Therefore the application does not imply a link between the remaining features and concepts.

2.4 Since the common concepts are known and the remaining concepts differ there can be no common inventive concept uniting the subject matter of the different groups of claims. Hence the application lacks unity.

Re Item V
Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

3 Before discussing novelty/inventive step the following observations w.r.t. the clarity of the claims need to be made:

3.1 A contradiction between step f) of claim 1 and the overall disclosure (cf. i.a. claims 2 and 8) arises in that red eye *detection* is in actual fact always applied to the corrected image whereas red eye *correction* may be applied to another image, notably to the main image (cf. Fig. 1(b), pg 16 lines 5-9). This ensures that detection processing will be performed on an image brought into a known and better defined quality: cf. pg. 2 l 8-14 and notably pg. 3 lines 8-11, and pg. 11 line 30-pg. 12 line 3, pg. 12 line 17-pg. 13 line 12, pg. 15 lines 20-22, pg. 16 lines 5-7, Figs. 1(b), 2(a), 2(b),4(a). This in turn is essential for solving the problem as discussed on pp. 1-3 of the description. In contrast to this, present claim 1 hints at red-eye *detection* being performed on a second image, *different* from the corrected image, with the latter however also somehow being used in the process of detection. No enabling disclosure for such a scenario could be found in the application documents which teach applying the red-eye detection to the corrected image. Indeed also no convincing reasons for proceeding otherwise can be found in common general knowledge nor in the application documents. The application does mention that, in the special case of uncorrectable images, detection may be applied to uncorrected images (pg. 19 line 6 and pg. 23 line 19), but note that even in this case the system is never applying a red-eye detector to a different image while simultaneously also using data from a (non-existent) "corrected" first image in the process of detection.

3.2 Claim 1 fails to cite that the "corrective processes" are restricted to corrections in the field of image enhancement (cf. pg. 2 line 12). They could presently be read on complete red-eye corrections performed on the first image, in contradiction to the description. This demonstrates that the disclosure is not sufficiently enabling over the full scope presently attributable to the claimed subject matter and that the term "corrective process" applied in claim 1 is ambiguous in the present context.

For the above reasons the subject matter of present claim 1 could presently also be mis-read on e.g. red-eye detection in image sequences comprising at least a first and a subsequent second image once one interprets the expression "corrective processing" as red eye correction in the first frame of the sequence

(including checking if there are any red eyes in which case this correction would certainly be beneficial) and if one interprets "detecting red eye defects in said second .. image using said corrected first .. image" as referring to the usual tracking performed in image sequences, i.e. searching for a region in the next frame in the vicinity of important regions of the previous frame. Hence, the scope of claim 1 extends to unrelated subject matter for which consequently also no sufficiently clear and complete disclosure can be found and the presently claimed subject matter does not find enabling support over its full width. Moreover, the subject matter of claim 1 therefore also accidentally lacks novelty (or at least an inventive step) w.r.t. red-eye detection in image sequences combined with eye tracking.

3.3 In order to definitively exclude any mis-reading on further unrelated subject matter it is further necessary

- to re-phrase "..analysing .. the ... image .." in claims 1 and 25 e.g. as "..performing image analysis operations on the ... image pixels..." (basis cf. i.a. pg. 2 line 10) as otherwise the claimed subject matter could also be mis-read on analysing the image data only w.r.t. its associated meta-data as anticipated by D2 ref. signs 66,68 of Fig. 2.
- to change "characteristics of an image" in step b) of claims 1 and 25 to "characteristics of *said* image".
- to rephrase the formulation of step c) in claim 1 which is vague and ambiguous. It remains unclear according to which reference scale "beneficial" should be gauged. Moreover, the claim wording could also be mis-read on unrelated subject matter, e.g. on determining if one is able to process the image at all - e.g. if memory constraints allow one to do so ("if .. can be .. applied"), or alternatively even on determining if one should apply only one as opposed to more corrective processes ("if one or more ..."). The overall disclosure indicates that one rather determines according to said plurality of characteristics if and which corrective process or processes could possibly improve image quality.

3.4 A contradiction between the claims as a whole and the term "may" on pg. 24 line 25 of the description arises because the description seemingly indicates on pp. 24-25 that the "3rd principle embodiment" (color conversion) may possibly not be combined with the other two principal embodiments. No claims are directed to this 3rd principal embodiment per se (Note that such claims would in any case lead to further non-unitary subject matter and the third principal embodiment has also not been searched per se but only in combination with the originally claimed subject matter).

3.5 The presence of two independent method claims 1 and 25 would also lead to an unclear and inconcise set of claims when analysed as a whole because claims 1 and 25 specify partially different features as well as apparently corresponding features in different terms, thereby rendering the actual matter for which protection is sought unclear.

3.6 It is not stated that the methods are automated and computer implemented. Thus they could refer to mere mental schemes in the form of user instructions for interactive manual red eye removal.

3.7 In claim 25 there is no link between steps c) and d) implied because it is not mentioned that the adapting in step d) depends on the output of step c).

3.8 In claim 26 the numbering of steps overlaps with the numbering of steps of claim 25 and the numbering of claim 26 also does not make clear that any corrective processes are applied before step b) of claim 25.

Group 1: claims 1-24

4 In light of the description, the subject matter of **claim 1** must be interpreted as i.a. covering the following interpretation:

1. first create a re-sampled image of a main input image, e.g. subsampled due to memory constraints - cf. i.a. Fig. 1(b) and also pg. 10 lines 18-27, pg. 11 lines 27-30, but note also that in view of Fig 1(b) this step is actually even optional and one may always work on the main image, and

2. then apply to the resulting image any conventional image enhancement if needed, e.g. tone scale conversion to compensate for underexposure, cf. also pg. 13 lines 17-22 of the application documents,

3. then apply to the enhanced image any conventional red eye detection scheme.

4.1 Hence, the subject matter of claim 1 (in so far as it is in line with the overall disclosure) lacks novelty w.r.t. D1 as can be seen from a comparison of Fig 1(b) of the application + Fig. 2 of D1 (see also corresponding description of D1):

	Fig. 2 of D1		Fig 1(b) of the Application
ref. sign	40	corresponds to	112,170-3
	58,60,63		130

44,50	135-1,135-2
44,51	90

Remarks:

1. As for steps c) and d) of claim 1: as mentioned this may amount to determining underexposure and then correcting the tone reproduction curve (cf. pg. 13 lines 17-22) before performing red-eye detection. Clearly such kind of processing is implied by ref signs 58,60,63,50 of Fig. 2 of D1.

2. In view of the foregoing, the fact that D1 additionally also teaches a separate further fine scan processing chain 46 is totally irrelevant for this objection.

3. In any case, even modifying D1 so as to use the red-eye detection result obtained in 51 to aid also in the red eye correction step in 55 would be trivial in order to save space, time and to ensure harmonised results in 20 and 16 of D1: hence even the not yet explicitly claimed embodiment on pg. 16 lines 5-9 of the present application documents would be obvious in light of D1.

4.2 The subject matter of claim 1 (in so far as it is in line with the overall disclosure) would additionally also lack an inventive step w.r.t. D2 as can be seen from a comparison of Fig 1(b) of the application + Fig. 2 of D2:

	Fig. 2 of D2		Fig 1(b) of the Application
ref. sign	62	corresponds to	112,170-3
	64		130
	76		135-1,135-2
	80		90

One might even argue that the present claim formulation is anticipated also by D2 because, depending on the obtained parameter values for e.g. the SBA shift in Fig. 2 D2 (e.g. if the amount of adjustments happens to be zero) no correction will occur and this should be sufficient to anticipate also steps c) and d) of current claim 1. In any case, it would be a totally trivial design modification of D2 Fig. 2 to apply the SBA shift correction 76 only selectively if needed, especially since paragraph [0068] already indicates the possibility to do so. Alternatively, it would be equally trivial to combine D2 with the ideas of ref. sign 48 of Fig. 2 of D1 and to augment D2 such that image analysis steps influence no longer only the SBA shifts 76 of Fig. 2 of D2 but

rather also the decisions in the image defect prediction process 68 of Fig 2. D2, in particular since it is well known that e.g. under-exposure can also be reliably judged from the image pixel data itself instead of meta-data.

4.3 Moreover, the interpretation of claim 1 cited above amounts anyway to a non-inventive standard juxtaposition of usually applied image processing operations (resampling, enhancing if needed, red-eye detection).

5 As for the dependent claims:

claims 2-4,6-24: known from D1,D2 ibid.
claim 5: trivial parallelization

Group 2: claims 25-47

6 The subject matter of independent **claims 25, 46,47** lacks novelty.

6.1 The expression "adapting said filter chain" in steps c)+d) of claim 25 can simply stand for changing parameters of a subsequent algorithm, cf. description pg. 15 lines 9-12 and claim 27.

6.1.1 Therefore the claimed subject matter lacks novelty w.r.t. image feature extraction and the subsequent use of these features for taking decisions in any algorithm consisting of various red-eye detection filtering substeps. This is common in red-eye detection in general, for an example cf. D3 Fig. 1. In D3 image features determine which processing route is eventually taken in a red-eye detection algorithm, i.e. which "red-eye subfilters" eventually will get employed.

6.2 Even assuming more sophisticated control, D1 teaches influencing the red-eye detection chain in both prescan or highscan image ("second image") in accordance with image features extracted from the prescan image ("first image"), cf. in particular, D1 Fig. 2 and paragraphs [0054-0060] and note that section 63 receives data from 40 (first image) and controls prescan red-eye filtering and unit 46 including sections 54,55,56 processing data from 42. The claimed subject matter thus lacks novelty. (Further note that the second image can be read on the prescan or the highscan image of D1. Hence, even disregarding the above objections w.r.t. lack of clarity and enabling disclosure, and nevertheless assuming that one were dealing with different images the subject matter of independent claims 25,46,47 would still lack novelty).

6.3 Moreover the subject matter of claims 25,46,47 would also lack an inventive step

w.r.t. D2 which teaches in Fig. 2 ref. signs 52,54,76 that a first image (sub-sampled image) is analysed to influence the overall processing chain 70 applied to a second image, wherein process 80 of chain 70 locates and removes red eyes (cf. also paragraph [0078] of D2) and chain 70 can thus be interpreted as "a chain to detect red eye defects". Note now that it would be a trivial design modification of D2 Fig 2 to apply the SBA shifts 76 only selectively if needed, especially since paragraph [0068] already indirectly indicates the possibility to do so. Alternatively it would also be possible to combine D2 with the ideas of D1 and to let image processing influence not only the SBA shifts 76 but also the decisions in the image defect prediction process 68 of Fig 2. D2.

7 As for the dependent claims:

claims 26-28,30-45: known from D1/D2, see above
claim 29: trivial parallelization.

CLAIMS:

1. A method for red-eye detection in an acquired digital image comprising the steps of:

a) acquiring a first image;

b) analysing the first acquired image to provide a plurality of characteristics of an image ;

c) determining if one or more corrective processes can be beneficially applied to said first acquired image according to said characteristics;

d) applying any such determined corrective processes to said first acquired image;

e) acquiring a second different image; and

f) detecting red-eye defects in said second acquired image using said corrected first acquired image.

2. A method according to claim 1 wherein said detecting step comprises applying a chain of one or more red-eye filters to said first acquired image; and further comprising the steps of, prior to said detecting step:

g) determining if said red-eye filter chain can be adapted in accordance with said plurality of characteristics; and

h) adapting said red-eye filter chain accordingly.

3. A method according to claim 2 in which said step of adapting comprises providing an altered set of parameters for one or more filters of said filter chain.

4. A method according to claim 2 in which said step of adapting comprises re-ordering a sequence in which said filters are applied to said first acquired image.

5. A method according to claim 2 in which more than one of said filters are applied simultaneously.

6. A method according to claim 2 in which said step of adapting comprises determining which filters are to be applied in said chain.

7. A method according to claim 1 further comprising the step of correcting a third acquired image based on any defects detected in said detecting step.

8. A method according to claim 7 wherein said first second and third images are the same image.

9. A method according to claim 7 wherein at least one of said first and second images is a sub-sampled copy of said third image.

10. A method according to claim 1 wherein said first acquired image is a sub-sampled copy of an acquired image.

11. A method according to claim 1 wherein said first acquired image is a sub-sampled copy of the second image.

12. A method according to claim 1 further comprising the step of:

prior to analysing the first acquired image, processing said second image based on the settings of a device used to acquire the second image.

13. A method according to claim 1 wherein said analysing step comprises determining one or more of:

a degree of blur;

a degree of dust contamination;

color balance;

white balance;

a gamma correction which might be applied;

texture characteristics;

noise characteristics; and

characteristics of regions;

in the first acquired image.

14. A method according to claim 1 wherein said analysing step comprises recognising one or more faces or types of face in the first acquired image.

15. A method according to claim 1 wherein said corrective processes comprise one or more of:

(i) contrast normalization and image sharpening;
(ii) image color adjustment and tone scaling;
(iii) exposure adjustment and digital fill flash;
(iv) brightness adjustment with color space matching;
(v) image auto-gamma determination with image enhancement.;
(v) image enhancement; and
(vi) face based image enhancement .

16. A method according to claim 2 wherein said red-eye filter chain comprises:
(i) a pixel locator and segmentor;
(ii) a shape analyser;
(iii) a falsing analyser; and
(iv) a pixel modifier.

17. A method according to claim 16 wherein said pixel locator and segmentor includes a pixel transformer.

18. A method as claimed in claim 1 comprising the step of: responsive to determining that corrective processing is necessary but cannot be beneficially applied to said first acquired image according to said characteristics, disabling said step of detecting red-eye defects and providing an indication of such to a user.

19. A method as claimed in claim 7 wherein said step of applying a corrective process includes interacting with a user to determine the corrections to be made to said third image.

20. A method according to claim 1 wherein the step of applying a corrective process includes performing a color space transformation.

21. A method as claimed in claim 1 in which one or more of steps a) to e) are performed in a digital camera.

22. A method as claimed in claim 1 comprising determining a sequence in which more than one corrective process can be beneficially applied to said first acquired image according to said characteristics.

23. A computer-readable storage medium containing a set of instructions which when executed on a digital image processing device perform the steps of claim 1.

24. A digital image processing device arranged to perform the steps of claim 1.

25. A method for red-eye detection in an acquired digital image comprising the steps of:

a) acquiring a first image;

b) analysing the first acquired image to provide a plurality of characteristics of an image ;

c) determining if a chain of one or more red-eye filters can be adapted in accordance with said characteristics;

d) adapting said red-eye filter chain;

e) acquiring a second image; and

f) applying said filter chain to detect red-eye defects in said second acquired image.

26. A method according to claim 25 further comprising the steps of:

f) determining if one or more corrective processes can be beneficially applied to said first acquired image according to said characteristics; and

g) applying any such corrective processes to said first acquired image.

27. A method according to claim 35 in which said step of adapting comprises providing an altered set of parameters for one or more filters of said filter chain.

28. A method according to claim 25 in which said step of adapting comprises re-ordering a sequence in which said filters are applied to said first acquired image.

29. A method according to claim 25 in which more than one of said filters are applied simultaneously.

30. A method according to claim 25 in which said step of adapting comprises determining which filters are to be applied in said chain.

31. A method according to claim 25 further comprising the step of correcting a third acquired image based on any defects detected in said detecting step.

32. A method according to claim 31 wherein at least one of said first and second images is a sub-sampled copy of said third image.

33. A method according to claim 25 wherein said first acquired image is a sub-sampled copy of an acquired image.

34. A method according to claim 25 wherein said first acquired image is a sub-sampled copy of the second image.

35. A method according to claim 25 further comprising the step of:

prior to analysing the first acquired image, processing said second image based on the settings of a device used to acquire the second image.

36. A method according to claim 25 wherein said analysing step comprises determining one or more of:

a degree of blur;

a degree of dust contamination;

color balance;

white balance;

a gamma correction which might be applied;

texture characteristics;

noise characteristics; and

characteristics of regions;

in the first acquired image.

37. A method according to claim 25 wherein said analysing step comprises recognising one or more faces or types of face in the first acquired image.

38. A method according to claim 26 wherein said corrective processes comprise one or more of:

(i) contrast normalization and image sharpening;

(ii) image color adjustment and tone scaling;

(iii) exposure adjustment and digital fill flash;

(iv) brightness adjustment with color space matching;

(v) image auto-gamma determination with image enhancement.;

(v) image enhancement; and

(vi) face based image enhancement .

39. A method according to claim 25 wherein said red-eye filter chain comprises:

(i) a pixel locator and segmentor;

(ii) a shape analyser;

(iii) a falsing analyser; and

(iv) a pixel modifier.

40. A method according to claim 39 wherein said pixel locator and segmentor includes a pixel transformer.

41. A method as claimed in claim 26 comprising the step of: responsive to determining that corrective processing is necessary but cannot be beneficially applied to said first acquired image according to said characteristics, disabling said step of detecting red-eye defects and providing an indication of such to a user.

42. A method as claimed in claim 31 wherein said step of applying a corrective process includes interacting with a user to determine the corrections to be made to said third image.

43. A method according to claim 26 wherein the step of applying a corrective process includes performing a color space transformation.

44. A method as claimed in claim 25 in which one or more of steps a) to e) are performed in a digital camera.

45. A method as claimed in claim 26 comprising determining a sequence in which more than one corrective process can be beneficially applied to said first acquired image according to said characteristics.

46. A computer-readable storage medium containing a set of instructions which when executed on a digital image processing device perform the steps of claim 25.

47. A digital image processing device arranged to perform the steps of claim 25.